

Infiltrate Object Extraction in X-ray Image by using Math-Morphology Method and Feature Region Analysis

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Abstract— Infiltrate is often called as pulmonary vlek for there are white spotted on the lung. White spotted could be in form of liquid, condensation, or uncircumcised. The liquid is emerge from blood or suppuration. To detect the existence of infiltrate on the lung, it could be done by doing X-ray Thorax checkup. To observe the infiltrate on x-ray thorax image is unable to be seen by every people, but it is done by experts such as radiologists or the pulmonary experts by doing conscientious research. The research was done by extracting the infiltrate object on x-ray thorax image of tuberculosis patient to clarify the object. The research stage that was done on x-ray thorax image is by detecting the object with segmentation morphology process which consist of dilation and erosion morphology, and side detection by decreasing the value of dilation and erosion morphology. The next stage is extracting the infiltrate object by using binarization and feature region analysis to ommit the unspotted part and determine the infiltrate object from the amount of existing objects. The result of infiltrate object extraction, then, is being calculated for both number and width of each side of lung by using feature region analysis. The result indicates that infiltrate object extraction is able to show an image with the explicit infiltrate object. The result trials of 40 x-ray thorax image on tuberculosis patients proved that the well-extracted images are able to be determined whether on its position, total, and width of infiltrates on lung. The trials of 2 x-ray thorax image on healthy patients are also done as comparisons, and the result indicates that there is no infiltrate objects on both sides of lung.

Keywords— infiltrate; tuberculosis; x-ray thorax; extracting; morphology; feature region

I. INTRODUCTION

The particular organ which attacked by tuberculosis is the lung, which is known as lung tuberculosis [1]. Early detection is urgently needed during the treatment on TB lung patient. It is done in order to prevent the physic derivation. The early detection on the abnormal organ is urgently needed since if it is known what is the major causer of an illness, then it will be easy to do an appropriate treatment [2]. To detect the tuberculosis on the lung is done by checking the result of x-ray thorax image [3]. It is preceed digitally, so the image process is able to be used to analyze the object among them is infiltrate.

X-ray thorax image is lung of tuberculosis patient which have infiltrates on it will be measured by the expert doctors.

Determining someone who has a lung disorder from x-ray thorax image, there are still some problems that occur in : (a) It could occur some different interpretations between radiologists and the expert of pulmonary. It is even possible that there are different interpretations between pulmonary doctors [4]; (b) It needs a long time to decide someone have lung disorder if it is seen from x-ray thorax image. Usually, it needs about one day to discover that someone has a lung disorder. After printing the result of x-ray thorax image, it

needs to be checked by the radiologist. Then, it's continued to be seen by the pulmonary doctor and being decided whether there is a lung disorder or not[5].

In this research there will be an extraction for one of the abnormality of the lungs, that is the object infiltrate extraction in x-ray thorax image of tuberculosis patient, so that the infiltrate object can be seen clearly and immediately. it also can equalize the interpretation between the radiologists and pulmonary expert, or among the pulmonary expert. From the result of the infiltrate object extraction then the amount and the size of the infiltrate in the right lung and the left lung will be known through the region analysis feature.

For infiltrate object extraction, the process that will be conducted is started by segmenting the image using morphology dilation and morphology erosion method. The combination of dilation morphology and erosion morphology method will produce the gray scale image and it can detect the side of the entire object in the lungs [8]. The gray scale image next will be transformed to binary image. From the binary image the object can be extracted and detected as infiltrate through the region analysis feature. The size can be known after the extraction of the infiltrate.

II. RESEARCH METHOD

To build the extraction systems of infiltrates object on x-ray image of the thorax tuberculosis patients required a research method that consists of stages are carried out, as can be seen in Figure 1.

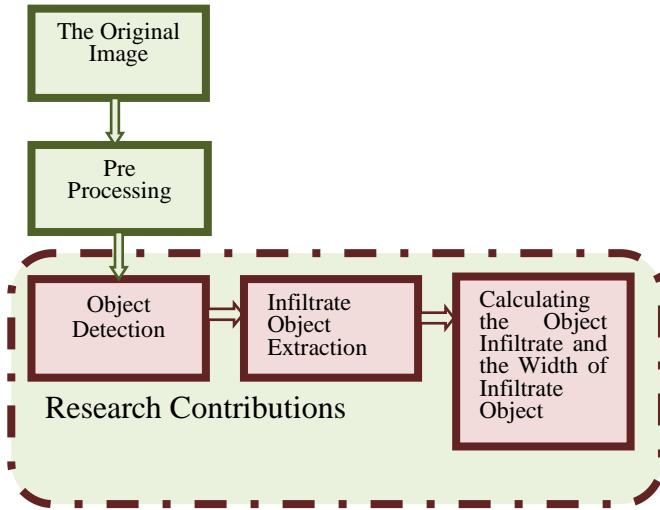


Fig 1 Research Stages

III. RESULT AND DISCUSSION

A. Original Image

The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes. Recommended font sizes are shown in Table 1.

The original image is used as the data input. The image is the x-ray thorax image in form of *. Jpg. All the test images used are the grayscale x-ray thorax image with 1760 x 1760 pixel, to standardized the dimension of the test image. There are 42 x-ray thorax images collected from adult patient with 2 healthy patients and 40 tuberculosis patient. There are the infiltrate objects known by expert in 40 x-ray thorax images of tuberculosis patient. The position of the infiltrate of 10 images from 40 images has been decided before the infiltrate extraction process conduct, and another 30 images after the infiltrate extraction object conducted.

B. Pre Processing by Cropping

Algorithm 1. Cropping Algorithm

1. Start
2. Read the original data image with `im = imread('citra1.either.jpg')`
3. Show the original data with `imshow(im)`
4. Set image size with `size(im)`
5. Set the right corner and the right corner under the right to the lungs with `p=ginput(2)`
6. Set point point left over and the corners left to the lungs the left with `q=ginput(2)`
7. Cropping lung image the right and the left lung image based on the point that has been determined with `MM(y0(2)y1(4), x0: x1,:)= im(y0(2)y1(4), x0: x1,:);`
`MM(y2(6)y3(8), x2: x3,:)= im(y2(6)y3(8), x2: x3,:);`
8. View image that has been in-cropping with `imshow(MM)`
9. Save images `imwrite(MM)`
10. Finished

Result :

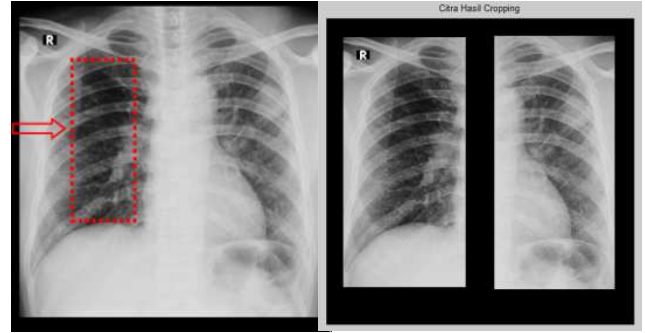


Fig 2 Original Image and the Result Image of Cropping Execution

C. Object Detection with Morphology Math

Methods of mathematical morphology with morphological dilation, morphological erosion and reduction of morphological dilation and erosion morphology process is capable of detecting objects that exist on the x-ray image of the thorax, including the infiltrates object (Figure 3).

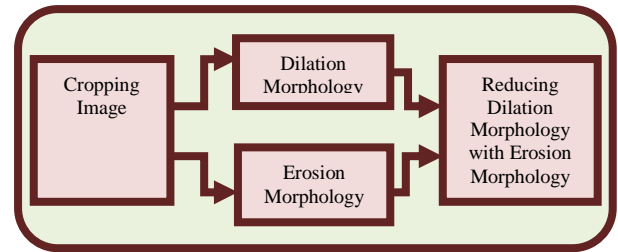


Fig 3 Process Diagram of Object Detection

1) Dilation Morphology

Algorithm 2. Dilation Morphology Algorithm

1. Start
2. Read image cropping result with `I = imread('citra1_1c.jpg')`
3. Elegantly cropping with `imshow(I)`
4. Set a side for the dilation morphology image with `se=strel('ball',7,7)`
5. Do the dilation morphology with `I2 = imdilate(I,se)`
6. View result dilation morphology with `imshow(I2)`
7. Save the product image dilation morphology with `imwrite(I2)`
8. Finished

Result:

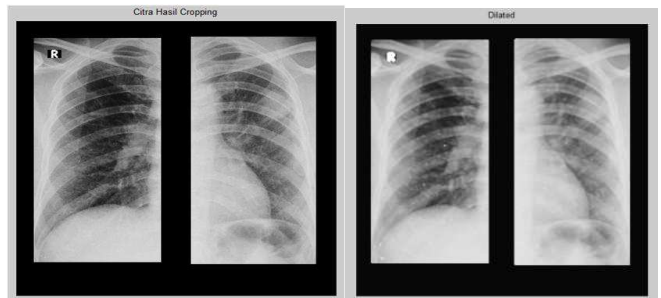


Fig 4 The image result of Cropping and Dilation Morphology

2) Erosion Morphology

Algorithm 3. Erosion Morphology Algorithm

1. Start
2. Read the image result of cropping with $I = \text{Imread}('citral_1c.jpg')$
3. Elegantly cropping with $\text{imshow}(I)$
4. Specify size for the erosion morphology image with $\text{se} = \text{strel}('ball', 7, 7)$
5. Do the erosion morphology by $I3 = \text{imerode}(I, \text{se})$
6. View result erosion morphology by $\text{imshow}(I3)$
7. Save result image process erosion morphology by $\text{imwrite}(I3)$
8. Finished

Result :

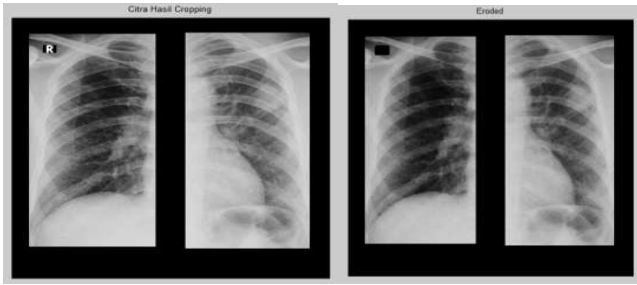


Fig 5 Original image and the Result Image of Erosion Morphology

3) The Decrement of Dilation Morphology with Erosion Morphology (Edge Objects Detection)

Algorithm 4. Edge Objects Detection Algorithm

1. Start
2. Read dilation morphology image with $D = \text{imread}('citral_2d.jpg')$
3. Read erosion morphology image with $E = \text{imread}('citral_3e.jpg')$
4. Elegantly dilation morphology with $\text{imshow}(D)$
5. Elegantly erosion morphology with $\text{imshow}(E)$
6. Subtract dilation morphology and erosion morphology by $DT = D - E$
7. Elegantly reduction result with $\text{imshow}(DT)$
8. Keep image of reduction result with $\text{imwrite}(DT, 'citral_4d-e.jpg')$
9. Finished

Result :



Fig 6 Original Image in form of Side Object Detection on Lung

D. Infiltrate Object Extraction

Extraction step of infiltrates object consist of binary process, calculating the area of each object, object removal which has an area that is larger than the object spots and ends with the extraction of infiltrates (Figure 7).

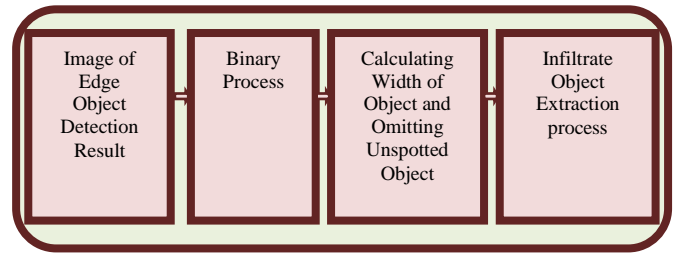


Figure 7 Process Diagram of Infiltrate Object Extraction

1) Binary Process

Algorithm 5. Binary Algorithm

1. Start
2. Read image of edge object detection result by $DT = \text{imread}('citral_4d-e.jpg')$
3. Elegantly edge object detection result with $\text{imshow}(DT)$
4. From edge object detection result do change their grayscale image to binary image with the son of $= DT > 42$
5. Elegantly binary result with $\text{imshow}(BIN)$
6. Keep image of binary result with $\text{imwrite}(bin, 'citral_5bin.jpg')$
7. Finished

Result :

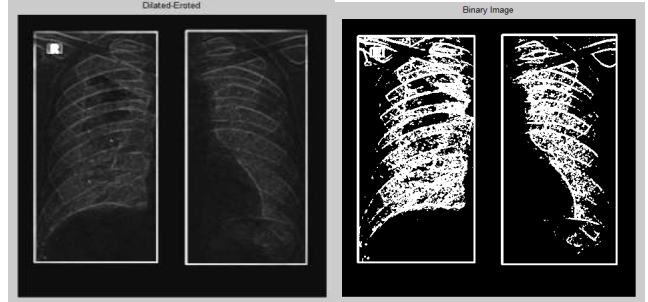


Fig 8 Original Image of Edge Objects Detection Result on Lung and Binary Image

2) Calculating Width of Object and Omitting Unspotted Object

Algorithm 6. Tracking Area and eliminate area algorithm

1. Start
2. Read the image of binary result with $BIN = \text{imread}('citral_5bin.jpg')$
3. Removed noise that is not the object in an area with $\text{bwconncomp}('imagebinner')$
4. Set area objects that are identified as spot ($\text{Regionprops}('imagebinner', 'Area')$)
5. If index of each area < 280 , do giving label and input in the areas that are identified spot with $(\text{ismember}(\text{labelmatriz}(\text{imagebinner}), \text{index}))$
6. View result image of each group area Buried image grouping result areas
7. Keep image that are identified as spot with $\text{imwrite}(AINF, 'citral_6ainf.jpg')$
8. Do the dilation morphology to clarify area objects that are identified as spot with $\text{se} = \text{strel}('disk', 2); I4 = \text{imdilate}(AINF, \text{se})$
9. Elegantly result that area the object was already made clear with $\text{imshow}(I4)$
10. Save result image grouping areas that are identified As spots that have been made clear with $\text{imwrite}(BINF, 'citral_7binf.jpg')$
11. Finished

Result :

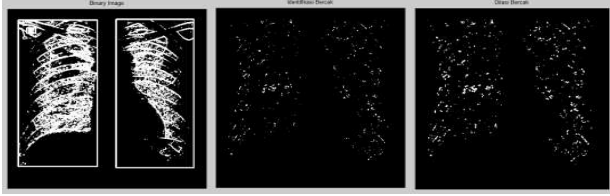


Fig 9 Original Image of Binary Result and Image Result of Spotted Identification

3) Infiltrate Object Extraction

Algorithm 7. Mapping Algorithm

1. Start
2. Read the image grouping result areas that are identified as spots that have been made clear with `BINF=imread('citral_7binf.jpg')`
3. `INF=BINF`
4. Set of each area objects and address list and pixels index passes, (`s1= regionprops (BINF, 'Area', 'pixellist', 'pixelidlist')`);
5. Set image size and number of areas (`M,N`)=`size (BINF)`;[`K,L`]=`size (s1)`;
6. Check position each object to `k`, Calculate the pixel every `k` (`AA(s1(k,1) . PixelList;Count size each pixel k ([HH,LI) = size (AA)`);
Set 0 for the number of `Sum=pixel k (double(0))`;
7. Check area next (`k=k+1`). Calculate The total value pixel `k` is divided into a pixel completely (`Av=Sum/KK`);If `Av > 53`, removing object (not the object was seeking).
`INF (s1(k).PixelIdxList)=0`
Sum values pixel resolution that has been identified as an object infiltrate every `k`,
8. View the final result (objects infiltrat who sought) with `imshow(INF)`
9. Save image area result object infiltrate with `imwrite (INF,'citral_8inf.jpg')`
10. Finished

Algorithm 8. Calculating the Object Infiltrate and the Width of Infiltrate Object algorithm

1. Start
2. Read image object result infiltrate with `INF = imread ('citral_8inf.jpg')`
3. Set of each area objects and address list and unthinkable index pixel screen res.-pixel screen res., (`s2= regionprops (BW , 'Area', 'pixellist', 'pixelidlist')`);
4. Specify size `s2`, [`K,L`]=`size(s2)`;
5. `Left=0;right=0;`
6. `Jright=0;Jleft=0;`
7. Check position each object infiltrate to `k`,
Count the pixel every `k` values if `AA(I,1)>=x0` and `AA(I,1)<=x1`, do `rightk(k)=s2(k).Area`;
`right=right+rightk(k);Jright=Jright+1`;
If not, do `blue(k)=s2(k).Area`;
`left=left+blue(k);Jleft=Jleft+1`;
8. View Right result, `Jright`, left and `Jleft`, `disp(['Area Right: ', num2str(right)])`; `disp((No. 'Area Left : ', num2str(left))`);
`disp(['Number of Infiltrate Right: ', num2str(Jright)])`;
`disp(['Number of Infiltrate Left : ', num2str(Jleft)])`;
9. Finished

Result :

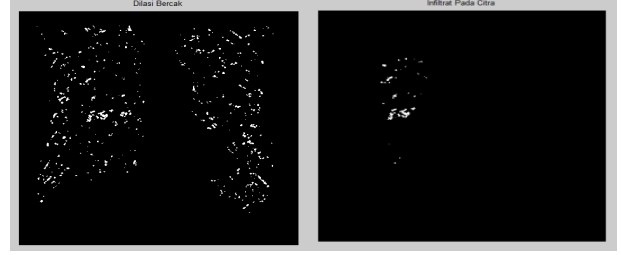


Fig 10 Image Result of Spotted Dilation Process and Image Result of Infiltrate Object

E. Calculating the Object Infiltrate and the Width of Infiltrate Object

The number and wide area of infiltrate objects can be counted by using the feature analysis region. Area of infiltrates object which have been detected can be quantified both for the lungs or the right and left lung. Based on the number of infiltrates the each are can be determined, so it can produce extensive infiltrates in the right lung, the left lung and the lung as a whole (Figure 11).

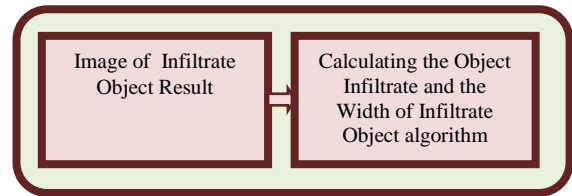


Fig 11. Process Calculating the Object Infiltrate and the Width of Infiltrate Object

After the 8 algorithm process there are 36 infiltrate in the right lung and no infiltrate in the left lung detected. There are 6614 pixel in 36 infiltrate detected. The *computed radiographytool* used produce 5 pixel/mm x-ray thorax image. 1 pixel equals 0,2mm. 1 pixel² equals 0,04mm² for the size. From the determination there are the calculations as follows:

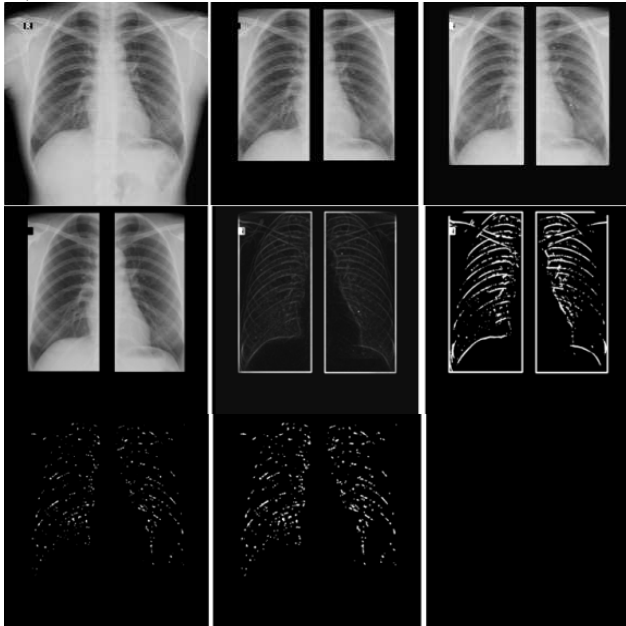
TABLE I
RESULT OF THE TOTAL INFILTRATE AND THE WIDTH OF INFILTRATE OBJECT

Image Name	The Original Image	Infiltrate Image Result	Number of Infiltrates		The Number of Pixels Infiltrates		Width of Infiltrate Object (mm ²)		Width of Infiltrate on the whole lungs (mm ²)
			Right Lung	Left Lung	Right Lung	Left Lung	Right Lung	Left Lung	
Citral.jpg			36	0	6614	0	264.56	0.00	264.56

F. X-ray Thorax Image From Healthy-Patient

The Change of image from the original image to the image that shows only the infiltrates object to the healthy patients can be seen in Figure 12.

1) First Patient



2) Second Patient

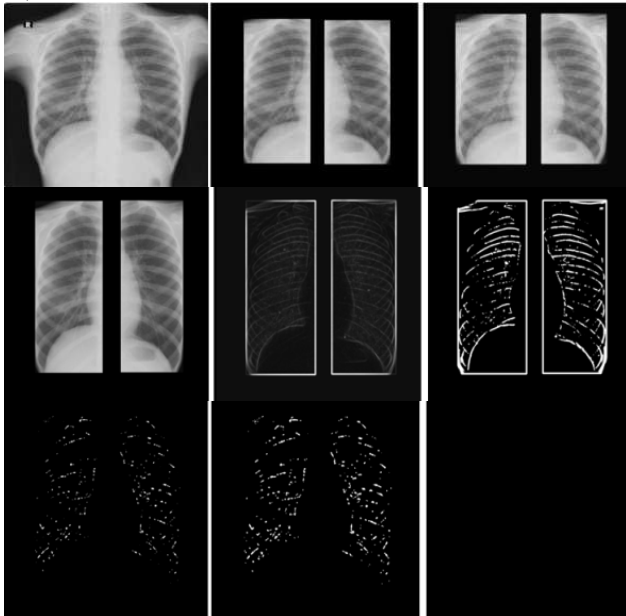
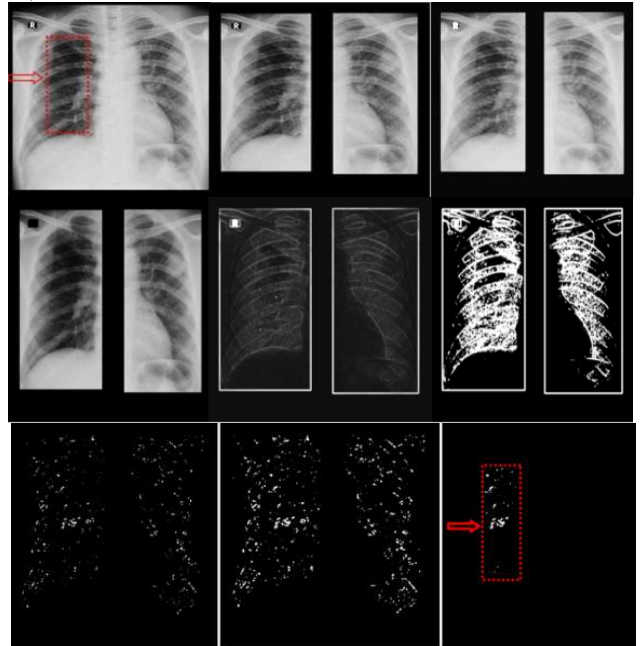


Fig 12 .The Changing of Original Object into the Result Infiltrate Object Image on the Healthy-Patient

G. X-ray thorax image from tuberculosis patient

The Change of image from the original image to the image that shows only the object infiltrates to patients with tuberculosis can be seen in Figure 13.

1) First Patient



2) Second Patient

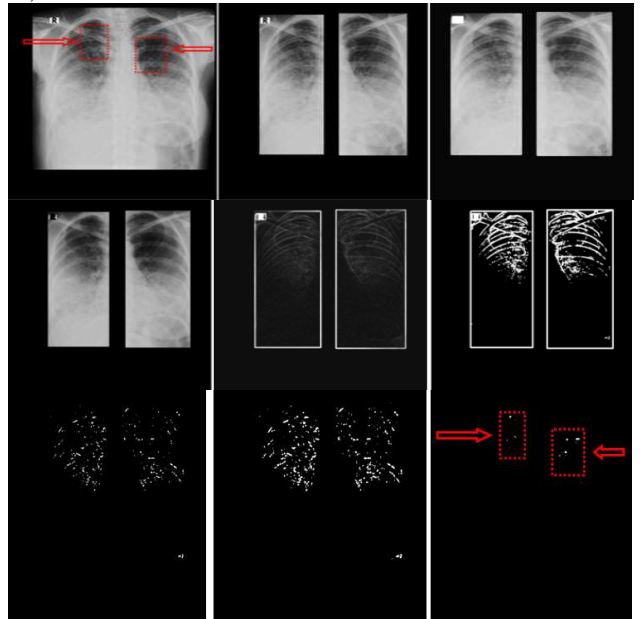



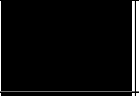


Fig 13 The Changing of Original Object into the Result Infiltrate Object Image on the Second Tuberculosis-Patient

H. Number of Objects Infiltrate and Width of Infiltrate Object

1) Healthy Patient

There were no infiltrates in the right lung and the left lung for both healthy patients.


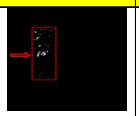
TABLE II
NUMBER OF OBJECTS INFILTRATE AND WIDTH OF INFILTRATE OBJECT

Image Name	The Original Image	Infiltrate Image Result	Number of Infiltrates		The Number of Pixels Infiltrates		Width of Infiltrate Object (mm ²)		Width of Infiltrate on the whole lungs (mm ²)
			Right Lung	Left Lung	Right Lung	Left Lung	Paru Kanan	Paru Kiri	
Citra_S1.jpg			0	0	0	0	0.00	0.00	0.00
Citra_S2.jpg			0	0	0	0	0.00	0.00	0.00

2) Tuberculosis patient

Number of Infiltrate Objects contained on right lung was 36 spots, while no infiltrates object in the left lung. Of the 36 spots the obtained results in a pixel number of 6614 pixels. Based on the provisions the tools used computed radiography, one pixel is 0.2 mm. To the extent one pixel² = 0.2 mm x 0.2 mm, so that one pixel² value is equal to 0.04 mm². From these provisions, it can produce the same calculations as Table 3.

TABLE III
NUMBER OF OBJECTS INFILTRATE AND WIDTH OF INFILTRATE OBJECT

Image Name	The Original Image	Infiltrate Image Result	Number of Infiltrates		The Number of Pixels Infiltrates		Width of Infiltrate Object (mm ²)		Width of Infiltrate on the whole lungs (mm ²)
			Right Lung	Left Lung	Right Lung	Left Lung	Paru Kanan	Paru Kiri	
Citra1.jpg			36	0	6614	0	264.56	0.00	264.56

IV. CONCLUSIONS

Based on the examination to the built algorithm it can be generalized that the infiltrate object extraction in x-ray thorax image using morphology method and region feature analysis produced a clear infiltrate object image. The position of infiltrate gets by pulmonary expert match the position of infiltrate from the algorithm implementation. In the case of healthy patient, from 2 test image, the algorithm implementation result matched the analysis of the pulmonary expert – there is no infiltrate in x-ray thorax image. In the test of 40 x-ray thorax images of tuberculosis patient where the position of the infiltrate of 10 images is already decided before the extraction process and 30 more after the extraction process, the position of the infiltrate decided by the expert matched with the position of the infiltrate of the algorithm implementation. Based on the infiltrate object result that has been extracted, the amount of the infiltrate of the test image of each lungs can be counted, then the amount of pixels and size of the infiltrate object can be known.

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